USACE Waterways Experiment Station

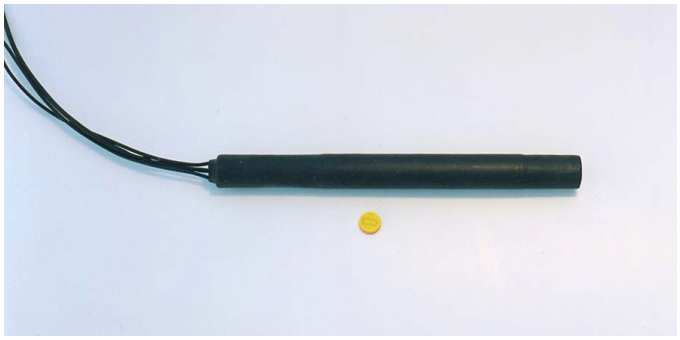
Xenon Ionization Detector for Cone Penetrometer Application

Technology Need:

Cone penetrometers have become an important tool for providing rapid in-situ vertical profiles of the soil composition at remediation sites. A variety of physical, chemical and nuclear sensors have been incorporated into the penetrometer probe in order to provide an overall analysis of soil contamination. Currently, NaI(Tl) [Thallium-doped Sodium Iodide] scintillation detectors are employed to measure radioactive subsurface contaminants. However, these detectors have insufficient energy resolution for distinguishing individual radioisotopes in a mixed radionuclide environment. There is a need for a new high-resolution radiation detector that can be incorporated into the cone penetrometer rod assembly (typically 1.25" inner diameter). Principal requirements are compactness, ruggedness, and the ability to operate under ambient temperature conditions.

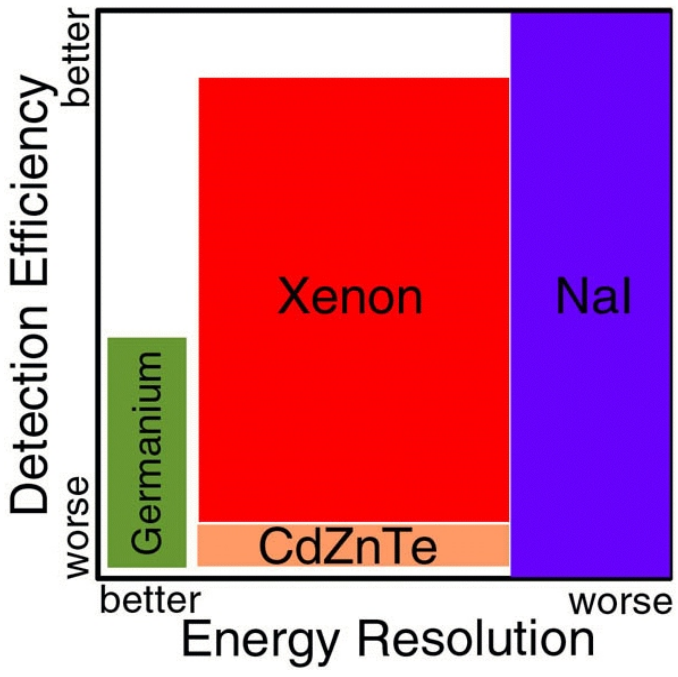
Technology Description:

The US Army Corps of Engineers (USACE) Engineer Research and Development Center Waterways Experiment Station (WES) will design and field-test a Xenon Gamma-Ray Spectrometer Probe for Cone Penetrometer System. WES will procure a high-pressure xenon gamma ray detector system from MIRMAR LLC of California and fabricate and assemble a xenon detector probe housing and umbilical cable compatible with standard cone penetrometer systems. WES will conduct shake down testing, final instrument calibration and simulated field validation testing. The detector is expected to provide a combination of energy resolution and thermal stability far superior to scintillation-based spectrometers and will provide the DOE with a powerful new tool for the characterization of subsurface radioactive contaminants.



MIRMAR's Small Xenon Detector

Typical scintillators like NaI(Tl) give energy resolutions in the range of 7-10%. By contrast, high pressure xenon detectors provide a resolution of approximately 2%@662keV. Furthermore, compressed xenon detectors can operate over a wide temperature range with negligible channel drift or energy resolution degradation making them particularly attractive for field applications where the



temperature cannot be controlled. Finally, the relatively high atomic number of xenon (Z=54) results in a detector efficiency that is comparable with existing solid state spectrometers. The challenge of the project is to adapt the high-pressure xenon technology to the special requirements of the cone penetrometer application.

Highly compressed and purified xenon has emerged as an important detection medium for high-resolution, room temperature gamma radiation spectroscopy in the energy range <5MeV. Detectors based on compressed xenon offer a unique combination of high-energy resolution (typically < 2%@662keV), variable volume and thermal stability. Furthermore, fluid based detectors are not susceptible to mechanical or radiation damage, and can be constructed in a variety of geometries. These features make compressed xenon detectors an attractive alternative to existing detector technologies that have proven inadequate for many field applications such as waste-site characterization, well logging and nuclear treaty verification.

Benefits:

- In situ monitoring of radioactive waste
- Very high room temperature energy resolution (<2%@662keV)
- Thermal stability
- Rugged, low cost spectrometer
- Easily scaled up to larger volumes for other applications

Status and Accomplishments:

WES has designed and is field testing the Xenon Gamma-Ray Spectrometer Probe for Cone Penetrometer System. WES procured a high-pressure xenon gamma ray detector system from MIRMAR LLC of California and fabricated and assembled a xenon detector probe housing and umbilical cable compatible with standard cone penetrometer systems. WES has completed their acceptance testing, and the detector met all performance specifications. A resolution of 3% or less was required, and the Mirmar detector exhibited a resolution of 2.44%. The detector is now being integrated with the probe housing and umbilical cable in preparation for the calibration process which should last 1 or 2 weeks and should begin late September 2002 at Mississippi State University (MSU). MSU has already ordered the radioactive sources required for the calibration, and are ready to move ahead with the simulated field demonstration with an actual penetrometer rig once the calibration has been completed.

Contacts:

John H. Ballard
The US Army Corps of Engineers
Engineer Research and Development Center
Waterways Experiment Station
Phone: (601) 634-2446
E-mail: John.H.Ballard@erdc.usace.army.mil

Ronald K. Staubly
National Energy Technology Laboratory
Phone: (304) 285-4991
E-mail: ron.staubly@netl.doe.gov

Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 2223
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov